DOCUMENT RESUME

ED 194 525 SP 017 099

AUTHOR Joyce, Bruce
TITLE Toward a Theory of Information Processing in Teaching. Research Series No. 76.
INSTITUTION Michigan State Univ., East Lansing. Inst. for Research on Teaching.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO IRT-RS-76
PUB DATE Mar 80
CONTRACT 400-76-0073
NOTE 26p.
AVAILABLE FROM Institute for Research on Teaching, College of Education, Michigan State Univ., 252 Erickson Hall, East Lansing, MI 48824 ($2.50).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Classroom Environment; Classroom Techniques; *Cognitive Processes; *Concept Formation; *Decision Making; Elementary Secondary Education; Interaction; *Perception; Student Behavior; *Teacher Behavior; Teacher Characteristics; Teacher Response; Teaching Styles

ABSTRACT

Drawing on a recent series of investigations into teacher information processing while teaching, a set of propositions to guide inquiry into the relationship between thought and action in the classroom are advanced. These propositions represent a "pre-theory"--steps toward defining the nature of information processing during teaching and the factors which determine its characteristics. The activity flow in a classroom so controls the kinds of information that teachers receive that they are very unlikely to process information in such a way as to move into a major decision-making frame. Teachers usually work within a general framework and "fine tune" that system. (Author/JD)

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Institute for Research on Teaching

College of Education, Michigan State University

Research Series No. 76

TOWARD A THEORY OF INFORMATION PROCESSING IN TEACHING

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Published By

The Institute for Research on Teaching
252 Erickson Hall
Michigan State University
East Lansing, Michigan 48824

March 1980

This work is sponsored in part by the Institute for Research on Teaching, College of Education, Michigan State University. The Institute for Research on Teaching is funded primarily by the Program for Teaching and Instruction of the National Institute of Education, United States Department of Health, Education, and Welfare. The opinions expressed in this publication do not necessarily reflect the position, policy, or endorsement of the National Institute of Education. (Contract No. 400-76-0073)

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Abstract

Drawing on a recent series of investigations into teacher information-processing while teaching, the author advances a set of propositions to guide inquiry into the relationship between thought and action in the classroom. These propositions represent a "pre-theory" -- steps toward defining the nature of information processing during teaching and the factors which determine its characteristics. The author found that the activity flow in a classroom so controls the kinds of information that teachers receive that they are very unlikely to process information in such a way as to move into a major decision-making frame. Teachers usually work within a general framework and "fine tune" that system.

TOWARD A THEORY OF INFORMATION PROCESSING IN TEACHING[1]

Bruce Joyce[2]

As in any cumulative line of inquiry, the first task is to try to learn the facts, and, in this case, the facts are what is going on in a teacher's mind. The study of information processing in teaching is at the fact-finding stage. Unfortunately, it is not yet known precisely where and how to look for the facts. This work is truly exploratory; some primitive tools and a limited vision are all that researchers have to go on right now. Even so, they have begun to develop some "sense" of the area and some concepts to guide future investigations.

In this paper, I present those concepts and propose a framework for looking at thinking in teaching. To some extent, I have drawn on information-processing research in fields other than teaching, but the major concepts emerged as I developed a better "feel" for my specific

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[1]The theory presented in this paper was primarily derived from the data obtained in the IRT-sponsored South Bay Study. That study is reported in the following four IRT publications:

R.S. 57 Teaching styles at South Bay School: The South Bay Study, Part I. B. Joyce & K. McNair, 1979.

R.S. 58 Teachers' thoughts while teaching: The South Bay Study, Part II. K. McNair & B. Joyce, 1979.

R.S. 59 Teachers' conceptions of pupils: The South Bay Study, Part III. G. Morine-Dershimer, 1979.

R.S. 60 Teacher plan and classroom reality: The South Bay Study, Part IV. G. Morine-Dershimer, 1979.

Also, see the Winter, 1978-79 issue of the Education Research Quarterly (Volume 3, No. 4) which reports and interprets the South Bay Study.

[2]Bruce Joyce is the director of Booksend Laboratories in Palo Alto, California. He was a senior researcher on the South Bay Study.

area of concentration.

Relevant Research on Information Processing

Research relevant to the present effort comes from both basic studies and applied research on information processing. An example of the former is highly controlled experiments in which stimuli are systematically varied so that types of potential cues can be investigated as variables. Examples of the latter occur in the development of instructional systems to train personnel, such as airline pilots, who, in the course of their duties, are required to process varieties of information.

Garner's (1974) summary of experimental studies emphasizes both the roles of stimulus variation and the functions of cognitive structure in determining what kinds of information will be selected and how it will be integrated. He argues that most stimuli are not perceived because human beings simply do not scan fields of stimulus tasks as an impersonal, multidimensional, information-processing system might. Human beings, rather, perceive what they have been taught or choose to attend to. Thus most of the information potentially available in any given setting is probably not attended to at all. In any situation, people are faced with the problem of determining what kinds of stimuli are available and what kinds of cognitive structures exist that influence selection of what will be perceived.

Shiffrin's (1976) review emphasizes that the capacity to process information is multifaceted. There are varying degrees of "masking" with respect to perception. For example, the human perceiver simply "covers over" stimuli which do not appear to be relevant and the perception of such stimuli is forgotten almost immediately. "Selective attention" is the name given to this process of stimuli differentiation on the basis of whether they are potentially relevant. The selection of stimuli to be focused on in a complex, unstructured situation involves the development

of a problem-frame. Consciously or unconsciously the perceiver imposes a structure. When instructional systems are constructed, considerable attention is paid to the display of information -- to the provision of a structure which will guide attention to relevant stimuli.

If the postulate that teaching is done in an extremely unstructured situation where a framework of attention has to be imposed is accepted, it is probable that the kinds of attention-focusing structure developed by teachers will have a considerable effect on the kinds of stimulus they believe are relevant. We would expect considerable individual differences in the structure of the teaching situation and in the teacher's ability to divide attention among the multiple potential inputs.

Personality as a Factor

Hunt and his associates (Harvey, Hunt, & Schroder, 1963) have contributed a theory that describes individual differences in information-processing capacity. They focus on the ability of individuals to differentiate stimuli and to integrate information as it is received. They see differentiation and integration capabilities as unitary in the sense that persons who are better able to differentiate are also better able to integrate. The most capable differentiators and integrators are characterized by complex and flexible conceptual structures. The least capable individuals attempt to maintain their existing cognitive structure. They ignore or distort information which does not fit into that structure. Persons with more flexible and complex structures are able to receive information which does not fit into their present categories and modify their conceptual structure in order to integrate that information.

In several studies of teaching it has been established that variety in teaching styles is a function of conceptual level complexity and that

teachers displaying more complex conceptual structures have a greater ability to acquire new approaches to teaching and integrate them into their ongoing styles than do teachers with less complex conceptual structures.) It would not be surprising if information processing were also a function of personality.

Marx's (Marx & Peterson, 1979) study of teacher perception of students using Brunswick's lens model indicates that the types of cues used by teachers as they make judgments about pupils vary considerably and also that teachers differ quite a bit in their accuracy -- including ability to judge pupil achievement in learning situations. The ability to structure the problem frame to differentiate relevant cues and integrate them accurately probably varies widely.

Elements of Information Processing in Teaching

From this general perspective, in-flight information processing can be seen as a series of overlapping dimensions: the flow of cues, perception of cues, interpretation of cues, processing of stimuli, and response behaviors.

The Flow of Cues

Information processing begins with the flow of cues (potential stimuli) from students. These cues are incredibly numerous, and include both verbal and non-verbal student behavior. Cues are not independent of the tasks presented to the students by the teacher; the students are not free simply to behave -- they respond to tasks, other children, and a variety of other influences from within and without the school.

Perceiving the Cues

Perception is the first stage of information processing. Theoretically, the proportion of potential stimuli actually perceived can range from zero to 100%. That is, cues could pass right by a person oblivious to them -- they would not be turned into stimuli. Similarly, it is theoretically possible for an attentive person to perceive all the cues presented to him/her. The first question, then, is how much and what kind of cues are perceived?

Interpretation of Cues: Accuracy and Distortion

Perception is not simply a mechanical process. Impressions of stimuli are not simply photocopied by the mind as they appear in the objective world. There is always a certain amount of distortion and interpretation. For example, if a student lifts his/her hand, the teacher may perceive a smaller or a larger movement than actually takes place. In addition, symbolic value is immediately attached to a stimulus. A raised hand may, for example, be seen as a call for attention or a gesture of annoyance.

Processing of Stimuli

Once perceived, the stimuli are processed in some way, first for relevance to the teacher's field of concern. If the lifting of the hand, for example, is interpreted as an attempt to relieve a cramp caused by writing, it may be processed as irrelevant. If it is classed as relevant, then it may be processed for comprehension (to understand it better) and possibly for action. *Next to an understanding of the stimulus field, probably the interpretation of stimuli is the most important of the mysteries to be unravelled at the outset of investigations into information processing.*

Response Behaviors

The action resulting from information processing is teacher behavior. The behavior may be overt or covert; the activity may be immediate or delayed.

To understand the nature of teachers' information processing, the nature of the flow of potential stimuli, perception, interpretation, and the response behaviors must be understood. Occasionally, these stages can be seen clearly, such as when there is a distinctive stimulus from a child -- the teacher manifests verbally an awareness of the stimulus and how it is interpreted, clearly decides whether it is relevant, and acts in response. Such a clear and full connection is rarely displayed, and evidence about one stage or another is frequently missing. At certain times, information is gained about the stimulus awareness (perception), at other times about processes, and still at other times, about behaving. However, the South Bay Study data (see Footnote 1) provide enough instances in which these dimensions are revealed, at least partially, to allow a preliminary framework to be pieced together. Also, the teachers were generous informants about what they see and how they interpret it -- they help to fill in the gaps. Reflecting on the South Bay Study data, I have begun to sense how these stages occur in the world of the classroom.

The Teacher as an Agent in Determining the Stimulus Flow

It is worthwhile to conjecture what the stimulus field might be like if the teacher were not present. The flow would be from the natural behavior of the children as they interact and pursue their own activities. Were we simply to gather 20 or 30 children together in a room, the primary source of stimuli would be the children themselves, albeit

somewhat affected by the environment. Teacher behavior changes the stimulus field in several ways:

First, the teacher establishes tasks. The process of establishing activities itself produces stimuli, but, most important, the teacher shapes the students into a flow of activities which characterize that particular classroom. These activities constitute the curricular and instructional system. For example, if a teacher organizes the students to select books from the library and read them silently, coming to him/her only when there is a question of comprehension, then some of the natural behavior of the students is replaced by the activities of selecting and obtaining the books, reading them, asking questions, and so on. Those activities generate patterns of behavior and become part of the stimulus flow.

Second, the teacher builds a social system or a community within the classroom. The social system is manifest (e.g., expressions of affection are legitimate within some communities, whereas task-oriented, business-like behavior is required in others). Some social systems are fairly spontaneous and induce free expression, whereas others are more constrained with a much narrower range of legitimate behaviors.

Third, the teacher regulates the stimulus flow through instructional moves with respect to both pace and diversity. In oral reading, for example, cues about word-attack skills will be plentiful. Unless there is discussion, there will be relatively few cues about comprehension of what is read. Some teachers tolerate stimuli from many students simultaneously, others from relatively few. Some teachers control stimulus emissions so as to reduce types of stimulus which cannot be conveniently responded to by automatic routines.

Thus the teacher is a powerful agent in determining the kinds of

information that can be processed by reducing the amount of natural behavior by the children, instituting instructional patterns, building a social system, and regulating the instructional process.

The stimuli can be seen partly as natural behavior by the children and partly as behavior induced by the activity flow. The patterns of interaction -- structuring, information handling, and feedback -- that the teacher institutes further affect the flow of cues. I propose that to understand the information-processing behavior of teachers, it will be necessary to understand the types of activity flow they create, their teacher's structuring, information handling, and feedback patterns; and the nature of the social system that is generated in their classroom. It will also be necessary to understand the types of stimuli which are generated by this combination of teacher induced and student-generated behavior. Without a map of the potential stimulus field, studies of thought processes will be severely limited.

Perception

Individuals differ widely in the extent to which they are aware of the behavior of others. The stimulus field of the classroom is a particularly complex one. Repeatedly, during stimulated recall interviews, the teachers in the South Bay Study (Joyce & McNair, Note 1; McNair & Joyce, Note 2; Morine-Dershimer, Note 3; Note 4) reported that as they watched the videotape they became aware of behavior which they did not notice at the time of the interaction. With so much happening all the time, there simply has to be some kind of selectivity.

The effect of the activity flow can be seen in the selectivity process. As the teacher establishes activities, s/he *expects* to see certain kinds of behavior. S/he thus becomes especially sensitive to

whether or not those behaviors are occurring. In other words, it is plausible that the teacher's very act of setting up activities prepares him/her for awareness. If the teacher wishes students to be working quietly at their seats, s/he will look around occasionally simply to determine whether quiet seat-work is going on, and so be more sensitive to indications of task-orientedness than to stimuli relevant to another dimension of student behavior. Processing involves extended interpretation of behavior for relevance, comprehension, and action.

Processing for Relevance

Awareness of a cue is not sufficient to ensure that much energy will be expended in processing it. Perceptions are screened for relevance according to a variety of criteria which differ by teacher. The determination of relevance is a sorting process by which it is determined whether a stimulus has sufficient meaning to warrant further thought. Those determined to be irrelevant do not stay long in the forefront of consciousness. For example, a teacher may notice that a student is scratching his foot, but dismiss the information immediately as not relevant. I believe the basic activity flow sets up implicit or explicit criteria by which relevance is determined.

Once the stimulus is determined to be relevant it can be subject to processing by one of several available routines. I have come to believe that there are at least three types of routines -- immediate action routines, delayed action routines, and comprehension routines.

Immediate action routines. An immediate action routine includes the rapid determination of stimulus relevance, the institution of a clear category system, a quick interpretation of the stimulus within

that system, and an immediate, almost reactive, teacher behavior. For example, if a teacher scans her students for attention at their seat work while she is working with a group of readers, her routines are held "at the ready." If a student leaves his seat and is observed, the cue is interpreted to be relevant and to match one of the "inattention" criteria. She may, for example, either give the child a "dirty look" (a technique employed when the child has visual contact with her), snap her fingers to obtain visual contact and follow that with a meaningful look, or snap her fingers and also beckon the child to her. These behaviors would probably occur with considerable rapidity following the cue (if it is observed).

Delayed action routines. The second kind of routine processes the information, but action is delayed. A teacher might process the student behavior stimulus just described in another manner. She may determine it to be relevant as an indicator of inattention, wait until she can make eye-contact with her aide, and then nod toward the child. It would then be the aide's responsibility to observe the child, to determine whether the inattention persisted, and take some sort of mild action if appropriate. The important difference is that the information is noticed in the same way, determined to be relevant by the same criterion, and stored for later delayed action.

Comprehension routines. Third, the information could be stored for later interpretation. For example, a teacher might notice one of his students having difficulty persisting in tasks involving the use of a sound system for teaching word attack skills. The information could be stored and later followed up on to determine whether the activity was an appropriate one for that child. After accumulating enough

evidence, a diagnosis would be made.

A fourth possibility involves a situation where no routine is available. It is in these cases that teachers must make a conscious decision about what to do. They may scan the elements of the activity flow that has been instituted and try to determine what the alternatives are. This is seen when an activity breaks down. A teacher may, for example, introduce an activity and then notice that the children are not behaving in terms of the criteria for successful task performance. If "unacceptable" stimuli continue to build up, the teacher may interrupt the activity and turn to another one. However, if the decision is made to persist with the activity, then a number of decisions have to be made about how to structure and handle information in order to guide the students to give appropriate responses. An indicated above, behavior may be overt or covert; it may be immediate or delayed. It may involve a very simple adjustment or the institution of new activities.

Thought and Action in the South Bay School

All of the teachers observed in the South Bay Study worked within the recitation style of teaching (Joyce & McNair, Note 1; McNair & Joyce, Note 2; Morine-Dershimer, Note 3; Note 4). This is a style in which the teacher asks questions to elicit knowledge of facts, and the students respond in kind (Hoetker & Albrand, 1969). The teachers' concerns about pupils and their interactive decision-making styles reflected the tasks of the recitation pattern. Nearly all decision making was of the "fine tuning" variety rather than a reflection on alternatives that would considerably affect the pace and flow of classroom activities. The South Bay School teachers had established a materials-based, tutorial flow of activity in which a teacher worked with an individual or small group

of children while the other children occupied themselves with self-instructional materials or attended to an aide.

The flow of activities generated in the recitation pattern enormously affects the stimulus field in two ways: first, by greatly influencing the behavior of the children (the field of potential stimuli), and second, by providing the teacher with criteria about which types of stimulus to scan for and which stimuli will be relevant. For example, students who are at their seats are expected to be working quietly at their assigned tasks. The teacher scans for evidence of on- and off-task behavior. A framework for detecting off-task behavior develops so that attention is focused on certain acts, while most other student behaviors (scratching, sharpening pencils, and the like) are usually not noticed by most of the teachers. If a child leaves his/her seat to sharpen a pencil the teacher generally will normally note that s/he has left his/her seat and will glance up shortly afterwards to see that s/he has returned to the assigned task. With respect to the group or individual being worked with directly, the teacher usually controls the flow by calling on one child or another and asking him/her a question or requesting him/her to perform. The teacher scans the child's performance for error and generally, except for reinforcing errorless behavior, does not respond to specific correct responses. Behavior judged to be in error is processed according to routines developed by each individual teacher. The result of the routine can be seen in overt teacher behavior (e.g., reiterating the directions of the activity, responding with immediate instruction, asking the student to repeat the task performance, and the like).

Within this teaching style, the teacher concentrates on the children with whom s/he is directly interacting, simultaneously scanning the rest

of the class for the presence or absence of task-oriented behavior. The teacher develops a number of relatively clear and simple routines for dealing with information from the students being interacted with directly. These routines also result in visible behavior. If students respond correctly, they are reinforced. If they do not respond correctly, they are corrected or the information is stored for future use. If one of the children not directly occupied with the teacher manifests off-task behavior, the teacher reminds the child of the desired behavior, notifies the aide, or reprimands the child, depending on the severity and type of infraction.

Several South Bay School teachers stood out as somewhat different from the others. One had great difficulty keeping the activity flow going and was more pre-occupied with student behavior and giving directions clearly. Another worked almost impassively with one student at a time, listening to the student read aloud but offering little corrective feedback, and engaged in almost no instructional behavior at all. Yet another teacher used a skill-oriented oral recitation system. She stored and utilized information about learner responses more fully and at a more rapid rate than any of the other teachers. When a student made an error, she did not respond immediately; she stored the information and returned to the student later. She could store information for as many as seven children at a time. She adapted the materials continuously to the learners and modified their assignments depending on their responses, thus operating a highly-efficient recitation system.

Testing the Concept: What do the Teachers Think About Our Thoughts About Their Thinking?

A series of précis were generated describing the information-processing routines that each of the South Bay School teachers appeared to be following.

These précis were developed by analyzing the data describing the teachers' teaching styles and by analyzing the stimulated recall protocols. Then, interviews were conducted with each of the teachers. At the beginning of the interview the teacher was asked to describe his/her system of teaching. Next, the description of his/her system of information processing written by one of the South Bay Study Researchers (Bruce Joyce, Kathleen McNair, and Greta Morine-Dershimer) was revealed to him/her for confirmation or disconfirmation. In all cases, the teachers confirmed the chief elements of the précis.

Because all of the teachers were working within the recitation style of teaching and they showed such small variability in decision-making styles, it is relatively difficult to make a general test of the concept of information processing presented here. However, teachers' confirmation of the descriptions of the information-processing paradigms they use is encouraging. Several interesting variations were confirmed by the interviews.

The social system within the recitation pattern is a task oriented one. The South Bay School teachers, however, differed quite a bit in terms of the details of that social system. One teacher set up a cooperative social climate. Although she worked with first-grade children, she was very careful to plan activities with them. When a student appeared to be engaged in off-task behavior, she responded by asking whether the student was clear about what s/he was doing and interrupted the activities to replan with the student. Another teacher permitted students to interrupt him while she was working with an instructional group and encouraged them to come for help at any time. Another did not want to be interrupted unless there were serious difficulties, and would ask a confused student to simply wait out the period and ask for help at a point of transition to the next

activity. Another teacher used the aide to help students with problems when she was working with an instructional group. And finally, one teacher changed during the study. She worked without an aide for some time and had considerable difficulty with discipline. She responded to off-task behavior within the instructional group or the seatwork group by annoyed, nagging behavior. When an aide was placed in the middle of the year, she used the aide to circulate among the students who were working at their seats and provide them with instructional help and bring them back on task. The aide did this quite successfully, and the teacher's nagging behavior was reduced markedly. She was able to give more attention to instruction with the small group of children she was working with at any given period. She gradually became more sensitive to cues about responses to instruction and apparently ignored many cues related to the on/off-task dimension of behavior.

Impressions From the South Bay Study: Concepts to Guide Our Next Studies

In the course of conducting the investigation and analyzing the data, my fellow researchers and I arrived at a series of impressions about the factors that influence teacher's information processing. These impressions directed us toward the development of sets of concepts that we believe will be useful in our further investigations.

The Influence of Long-Term Decisions

We formed the impression that most of the important preactive decisions made by teachers are long-term in their influence (as opposed to the influence of lesson by lesson planning). Early in the school year, most teachers set up a series of conditions that will be powerfully

influential on the possibilities of decision making thereafter. Lesson planning, to the extent that it goes on consciously, involves the selection and handling of materials and activities within the framework that has been set up by the long term decisions. We believe this is why investigations of teachers' lesson planning (see Clark & Joyce, 1980; Clark, Peterson, Marx, & Crist-Witzel, Note 5; Popham, & Baker, 1970; and Joyce & Harootunian, 1966) have found that teachers plan lessons in terms of activities and arrangements for those activities rather than using the objectives-activities-evaluation paradigm favored by most theoreticians of instructional design. Specific lessons occur within the general flow--their objectives are implicit and decisions are concentrated around the materials at hand and the adjustment of procedures for the episode.

The Flow of Activities and the Selection of Materials

Most of these important, long-term, preactive decisions involve the selection of instructional materials and the development of a flow of activities which will enable children to approach the tasks embedded in the material. In conformity to expectations by other teachers, school administrators, community members (chiefly parents) and, occasionally, the trends in curriculum and instructional theory, a set of instructional materials is selected and assembled. In reading and arithmetic, a basal text or equivalent materials are usually selected.

An activity flow is built around those materials and that flow becomes the most powerful influence in subsequent information processing. *In effect, the selection of materials and the subsequent activity flow establishes the "problem frame" -- the boundaries within which decision making will be carried on.*

Within this activity flow, most teacher information-processing behavior represents the fine tuning of the system of activities that has been established. The establishment of the activity flow greatly influences the potential stimuli to which the teacher can respond and establishes routines through which s/he will respond. It also establishes the parameters within which off- and on-task behavior will be defined as well as appropriateness or correctness of response. Nearly all teacher information processing responses are to signals of off-task behavior or inappropriate student responses. The purpose of most established routines is to bring about increased on-task behavior and appropriate (substantively correct) response to instructional tasks.

By constraining pupil behavior, the development of the instructional flow influences the availability of stimuli, creates routines to be used to deal with task-related responses by the students, and creates the parameters within which the "fine tuning" of the system will take place.

Once the activity flow has been established, teachers very rarely make decisions which change the direction of instruction or mobilize resources outside that activity flow frame. Differences in friendliness toward learners, conceptual complexity, personal philosophy, and momentary disposition influence information-processing behavior *within* the broad flow of activities and its network of routines.

Teacher concerns divide themselves into those oriented toward pupil achievement (appropriate response to the content of tasks) and involvement (the maintenance of the on-task behavior). Thus, the selection of an instructional model, either through the adoption of materials or a philosophy of instruction establishes the problem-frame and more powerfully influences information processing than does stylistic variation

(individual differences) among teachers.

We have been greatly influenced by this impression that relatively few major decisions are made once the basic activity flow is established, and the corollary impression that most information processing is nonetheless complex. Within the flow of activities, teachers are constantly receiving information, processing it, and responding to it. They rarely make decisions which radically change the direction of instruction.

When we commenced our work, we anticipated that we would find a fair amount of directional decision making, that is, that teachers would be receiving information which caused them to decide to use a different method, different materials, or major regroupings of the students. Such was not the case. The picture that emerges is that the teachers work within the general framework and "fine tune" that system. In other words, teachers do not think as instructional designers do, continuously selecting new methods and materials and ways of reaching children, but work within a general design that has emerged in the classroom.

Thus future investigations should concentrate on ways that teachers process information within the context of long-term decisions. We would hypothesize that unless the activity flow completely breaks down few teachers will, in the ordinary course of events, redirect it. In fact, the activity flow so controls the kinds of information that teachers receive that they are very unlikely to process information in such a way as to move into a major decision-making frame.

Our next steps will be to probe the nature of the potential stimulus field and the nature of the criteria used to select from it as scanning goes on. It is important also to learn how much the findings

from this study are a result of the instructional approach used here. Would the teachers behave the same were they teaching inductively or non-directively? Would the use of a different approach to teaching change the available cues, the nature of the criteria for selecting the cues to attend to, and the routines for processing information and responding? Thus we will study teachers as they use a variety of models of teaching and compare the findings to those obtained about the prevalent style at the South Bay School.

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